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Dmitry Kochetkov,
senior analyst,
Center for Regional Economic Studies,
Graduate School of Economics and Management,
Ural Federal University named after the first President of Russia B. Yeltsin
e-mail: kochetkovdm@hotmail.com
Ekaterinburg, Russia

THE IMPACT OF THE KNOWLEDGE ECONOMY INDICATORS ON REGIONAL ECONOMIC GROWTH: EVIDENCE FROM RUSSIA

Abstract:
The purpose of this study is the evaluation of the impact of the knowledge economy indicators on the level of regional economic development, as measured by the gross regional product (GRP). Grounding on the World Bank's Knowledge Economy Index, we have developed the original Russian Knowledge Economy Index. Then, we allocated the leading and the lagging regions in terms of the knowledge economy.

Keywords:
Regional development, knowledge economy, index.

Introduction

The knowledge economy has its origins in the work of Joseph Schumpeter (Schumpeter, 1934), who formulated the concept of economic growth based on the diffusion of innovation. The Austrian and American economist Fritz Machlup conducted influential research on the classification of knowledge (Machlup, 1962), classifying knowledge due to its application to areas of economic activities. D. Stigler considered knowledge as an economic category with an emphasis on information search costs (Stigler, 1961). It was Peter Drucker, however, who disclosed the role of knowledge in the creation of added value in the 1970s (Drucker, 1977). Drucker emphasized the significance of knowledge as the main economic resource of the new society. The Lisbon Strategy of the European Union ("Lisbon European Council 23 and 24 March Presidency Conclusion", 2000) stated these theses.

Much has been said about innovation, the knowledge economy, technological modernization and the diversification of the economy (Gluhov, 2003; Higher School of Economics, 2008; Makarov, 2003) in Russia over the course of the past 15 years. However, despite the fact that regional knowledge clusters form essential "building blocks" for the knowledge economy and knowledge-based society at

national and global levels, very little attention has been paid to the modelling of knowledge generation at a regional level. The primary purpose of our study is a ranking of the Russian regions in terms of the knowledge economy development utilizing the original technique. Analysis of the ranking results will enable further institutional analysis of regional policies and practices.

Methodology

At the global level, two international organizations conduct the analysis of the knowledge economy indicators. These are the Organization for Economic Cooperation and Development (OECD) and the World Bank (WB). These techniques have been engineered to analyze the level of development of the knowledge economy at the national level. Despite the fact that Russian statistics are still quite limited, we believe that their partial use, after appropriate adaptation, is applicable for the purposes of this study.

Based on the above-mentioned methods of the international indexes, data was selected from statistics available in Russia. The indicator of investment into fixed assets was also included; this was because, in our opinion, it best indicates the quantitative aspect of modernisation in transition economies. The diverse statistical population was formed on the basis of data from the Russian Federal State Statistics Service ("Federal'naja sluzhba gosudarstvennoj statistiki [Federal state statistics service]", n.d.) as follows:

A. Innovation and technology level

(1) Labour productivity index;

(2) Share of high-tech and knowledge-intensive industries in GRP;

(3) Innovative activity of organisations (the ratio of organisations implementing technological, organisational and marketing innovations to the total number of organisations);

(4) Share of innovative products, works and services in the total volume of shipped goods, works and services;

(5) Advanced manufacturing technologies used;

(6) Current domestic expenditures on research and development;

(7) Expenditures on technological innovations of organisations;

(8) Investments in fixed assets per capita;

B. Science and education development level

(9) Ratio of inventive activity (the number of domestic patent applications for inventions filed in Russia, per 10 thousand people of the population);

(10) Number of employees engaged in research and development;

(11) Number of graduate students in the regions of the Russian Federation;

(12) Number of doctoral students in the regions of the Russian Federation;

(13) Number of educational institutions of higher education;

(14) Number of students enrolled in undergraduate, graduate and master's programmes;

(15) Number of faculties of higher education institutions;
C. Use of information and communication technologies (ICT):
(16) Proportion of organisations using a personal computer;
(17) Proportion of organisations using the Internet;
(18) Proportion of organisations with a website;
D. Institutional regime
(19) Ranking of regional democratisation.

These 19 variables and indicators are model inputs characterising the level of development of the knowledge economy in the region. We chose Gross Regional Product (GRP) as an output or resultant variable, since it is the most objective indicator of economic development. In the case of variables (12) (13) (14) (15), data was only available for the year 2012. Data for variable (19) – ranking of regional democratisation – was calculated in 2010. All other variables used data relating to the year 2014. However, we consider it permissible to use this data for analysis because institutional factors and indicators of education affect the economy with a lag of several years.

GRP and variables (5), (6), (7), (9), (10), (11), (12), (13), (14) are absolute; the remaining (except (19), which is a ballpark qualitative assessment) are relative. In order to make them independent of the region's size and diversity of the data, we decided to normalise these figures according to the formula:

$$I = \frac{Vraw - Vmin}{\text{Vmax - Vmin}}, \quad (1)$$

where I is the normalised value of the index; Vraw – the current value of the index; Vmin – the minimum value of the range, Vmax – the maximum value of the range.

The next stage of the study was the correlation analysis, the purpose of which was the determination of the potential relationship between the variables and GRP. At the first stage, we found a negative correlation with variables (1) and (2); we also faced intercorrelation between variables (5), (6), (7), (9), (10), (11), (12), (13), (14), (15); (10), (11), (12), (13), (14), (15) and (19), also (16) and (17). As a result, it was decided to leave variables (8) and (18) for further analysis. We gave selection preference to the variables that have a higher correlation coefficient with GRP.

Using the resulting data set, a multiple regression equation by the Stepwise technique was devised. Selection was conducted by the forward method, i.e. gradual addition of indicators testing the coefficient of determination R^2. If the index did not increase the value of R^2, we exclude it from the regression equation.

Further, a final ranking was assigned to Russian regions in terms of the knowledge economy. It was called the Russian Knowledge Economy Index (RKEI). The simple addition of each indicator's value does not add up to the ob-

jective composite index, because each of the indicators affects GRP in varying degrees. Accordingly, each of the indicators was assigned a weighting coefficient. Coefficient corollaries of particular indicators were used with GRP as weighting coefficient. For the analysis of the final knowledge economy index, statistical methods to identify leading and backward groups were used. We determined the number of groups according to the Sturgess formula:

$$n = 1 + 3.322 \log N = \log_2 N, \quad (2)$$

where n is the number of groups, N – the number of units in the population. In turn, we determined the size of the interval by the formula:

$$i = \frac{(Xmax - Xmin)}{n}, \quad (3)$$

where *i* is the interval size, Xmax – the maximum value of the index, Xmax – the minimum value of the index.

Results

Table 1 represents the correlation coefficients obtained in the first stage of the study.

Table 1

Correlation of the knowledge economy indicators of the region with GRP

#	Indicator	Correlation with GRP
(3)	Innovative activity of organisations (the ratio of organisations implementing technological, organisational and marketing innovations to the total number of organisations)	0.219
(4)	Share of innovative products, works and services in the total volume of shipped goods, works and services	0.134
(6)	Current domestic expenditures on research and development	**0.937**
(8)	Investments in fixed assets per capita	0.063
(9)	Ratio of inventive activity (the number of domestic patent applications for inventions filed in Russia, per 10 thousand people of the population)	**0.700**
(18)	Share of organisations with a web-site	**0.508**

The highest correlation coefficients were found in case of variables (6), (9) and (18).

Multiple regression gave a strong enough coefficient of determination R^2 = 0.89. The result of the F-test determining the significance of the equation as a whole is equal to 101.87; this is much larger than the tabulated value of the test (F = 2.23) at a significance level of 0.05.

Table 2 shows the leading and backward groups of regions in terms of the knowledge economy development. Calculation of individual indicators was conducted with adjustment for the weights.

Table 2

Leading and backward groups of Russian regions in terms of the knowledge economy development

Ranking	Region	Innovative activity of organisations	Proportion of innovative products, works and services	Current domestic expenditures on research and development	Investments in fixed assets per capita	Ratio of inventive activity	Proportion of organisations with a web-site	Index of the knowledge economy
1	Moscow (federal city)	0.139	0.025	0.937	0.003	0.700	0.508	2.312
2	Saint Petersburg (federal city)	0.140	0.027	0.190	0.002	0.367	0.436	1.162
3	Moscow region	0.062	0.029	0.294	0.002	0.254	0.231	0.872
4	Tomsk region	0.100	0.008	0.053	0.002	0.386	0.202	0.752
5	Republic of Tatarstan	0.152	0.046	0.044	0.004	0.261	0.241	0.748
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80	Transbaikal region	0.037	0.016	0.002	0.001	0.041	0.096	0.193
81	Krasnodar region	0.043	0.003	0.024	0.003	0.105	0.010	0.189
82	Tyva Republic	0.010	0.000	0.005	0.001	0.004	0.077	0.097
83	Chechen Republic	0.000	0.004	0.003	0.001	0.023	0.052	0.082

Conclusions

The role of knowledge in the innovative socio-economic development has become absolutely critical: knowledge has become a major factor of economic growth and a key social value. A significant unit of the knowledge economy is comprised by the regional economic system. Russian regions were ranked in terms of their knowledge economy development. As a result, the Russian Knowledge Economy Index (RKEI) was formed. Available statistical indicators of the knowledge economy development were selected with GRP being chosen as the main output of the model or resultant variable.

The study has found correlations between, on the one hand, current expenditures on R&D, inventive activity ratio (the number of patent applications) and the proportion of companies having their own website in the region and, on the other, the volume of GRP. The correlation with other indicators under consideration revealed second-level factors. The resulting knowledge economy index has empowered analysis of the characteristics of the regions, which are at the top and bottom of the list.

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